RESEARCH NOTES ABOUT HISTORY OF THE SOLAR ENERGY TECHNOLOGIES (XIX-XX): HERITAGE, ARCHIVES & MEMORY

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1.- Introduction.

A research about Solar Energy Technologies since 2009 has been developed as a History of Technology[1] combining Environmental, and Economic History through cultural factors. One contribution of the results is the enlightenment of a large collection of cases[2], which must be studied and analyzed under a theoretical point of view, because it reveals an anomaly for the progressive conception of the evolution of technology.

* This paper has been produced thanks Chilean Fondecyt project No. 11180158 (2018-2021): "The solar borders of Chile: Desert, Antarctica, Polynesia, and Space. A history of governance and social values of solar technologies in extreme zones (1976-2011)", and Project HAR2016-75871-R (2017-2020): "Mathematics and Engineering: new critical viewpoints (XVI-XX centuries)", Barcelona Tech (UPC).

1 EDGERTON, D. (2004) "De la innovación al uso: diez tesis eclécticas sobre la historiografía de las técnicas". *Quaderns d'història de l'enginyeria*, VI, 1-23; EDGERTON, D. (2007) *Innovación y tradición: historia de la tecnología moderna*, Barcelona, Editorial Crítica; EDGERTON, D. (2010) "Innovation, Technology, or History. What is the Historiography of Technology About?", *Technology & Culture*, 51, 3, 680-697; GILLE, B. (1999) *Introducción a la historia de las técnicas*, Barcelona, Editorial Crítica; HUGHES, Thomas (1987) "The Evolution of Large Technological Systems". In: BIJKER, W. E.; HUGHES, T. P; PINCH, T. J. (eds) *The Social Construction of Technological Systems,* Cambridge, MIT Press, 51-82; SMITH, Merritt; MARX, Leo (1994) *Does Technology Drive History? The Dilemma of Technological Determinism*, Cambridge, MIT Press.

2 Since 2009, the present research benefited from three projects supervised PhD Nelson Arellano: 1. Doctoral thesis (2010-2014): *Engineering and artifactual discard of solar water desalination: the industries of Las Salinas, Sierra Gorda and Oficina Domeyko (1872- 1907) in Atacama Desert, South America* (UPC - Barcelona Tech). 2. Researcher in charge the Postdoctoral project (2016-2018): Fund of Scientific and Technological Research (Fondecyt-Chile) N ° 3160197: "The evolution of technology and the problem of sustainability: the incidence of cultural factors in the discarding of technologies of solar energy. Analysis of the saltpeter industry in Chile (1907-1981) ". 3. Researcher in charge of Chilean Fondecyt project No. 11180158 (2018-2021): "The solar borders of Chile: Desert, Antarctica, Polynesia, and Space. A history of governance and social values of solar technologies in extreme zones (1976-2011)", Universidad Academia de Humanismo Cristiano (UAHC).

The program of this research could be understood as a part of the main stream of the History of the technology and it has been developed and sustained by an envirotech perspective, cultivating a connection between the anthropological conceptualization of the Nature/Society dichotomy, and the environmental Humanities discussion[3].

The process, along 10 years, has allowed collecting a large number of cases of technologies as microhistories[4], including their techniques, objects, inventors, investors, places, and records. All these form a kind of segmented body. This is a heuristic process orientated to build an emblematic memory from loose memories[5].

One of the most significant challenges for the solar energy technologies and their narratives is the heritage they leave. We have an important number of cases around the world where compounds, factories, facilities, tools and most of the material elements vanished, and worse than that: their memories were lost. We would like to call attention to this dimension of the phenomena and the problem that remains invisible and silent.

3 EMMETT, R. S., & NYE, D. E. (2017) *The environmental humanities: a critical introduction*, Cambridge, MIT Press.

4 CONANT, James (1957) *Harvard case histories in experimental science*, Cambridge, Harvard University Press; DAVOINE, Françoise (2013) "Clínica de lo extremo, Entrevista con Dori Laub", *Le Coq-Héron*, Érès, Paris, 214, 143-158; FLYVBJERG, Bent (2004) "Cinco malentendidos acerca de la investigación mediante los estudios de caso", *Reis. Revista Española de Investigaciones Sociológicas*, 106, 33- 62; GINZBURG, Carlo (1981) *El queso y los gusanos: el cosmos de un molinero del siglo XVI*, Barcelona, Muchnik [first translation from: GINZBURG, Carlo (1976) *Il formaggio e i vermi. Il cosmo di un mugnaio del '500*, Turín, Einaudi]; SANHUEZA, Carlos (ed.) (2017a) *La movilidad del conocimiento científico en América Latina. Objetos, prácticas, instituciones. Siglos XVIII-XX*, Santiago de Chile, Universitaria.

5 ARELLANO, Nelson (2014) "Los ingenieros británicos en la Sudamérica del siglo XIX", *Quipu Revista Latinoamericana de Historia de las Ciencias y la Tecnología*, 16, 1, 39-62; ARELLANO, Nelson (2015) *La ingeniería y el descarte artefactual de la desalación solar de agua: las industrias de Las Salinas, Sierra Gorda y Oficina Domeyko (1872-1907)*, tesis para optar al grado de doctor, Universidad Politécnica de Cataluña; ARELLANO, Nelson (2016) "El debate de la energía solar para la desalación de agua en 1884: rastros de un discurso desatendido", *Quaderns d'història de l'enginyeria*, 15, 449-467; ARELLANO, Nelson (2017) "El desierto de Atacama como laboratorio: experimentos y tecnologías de la energía solar (1872-1981)", *Aldea Mundo*, 22, 044, 81-89; ARELLANO, Nelson (2018a) "La energía solar industrial en el desierto de Atacama entre 1933 y 1952: Investigación, desarrollo y sustentabilidad", *Estudios Atacameños*, aceptado para publicar; ARELLANO, Nelson (2018b) "MIT, Universidad de Barcelona, CORFO y Batelle Institute: búsquedas paralelas del poder solar en la década de 1970", *Quaderns d'història de l'enginyeria*; ARELLANO, Nelson; ROCA-ROSELL, Antoni (2018) "Solar energy technologies: unity and disunity of loose European memories", Pannel for European Society for the History of Science, Biennial Conference 2018 in conjunction with the British Society for the History of Science. London, 14-17 September, Theme: Unity and Disunity.

The awareness of the existence of the heritage of Solar Energy Technologies is possible thanks to a fragile and entangled record spread in different places of the western world and a small number of eyewitnesses sometimes preserved in archives. It seems that Solar Energy Technologies have been discarded at least three times since the XIX century. Nevertheless, in some cases, they were successfully adopted and adapted, but, apparently, they were priceless. In this sense, Solar Energy Technologies offer a rich field for the study, and a cross check between Heritage of Industry and Technical and Cultural landscapes. This approach is viable thanks to an interdisciplinary vision based on a sustainability discussion, opening the black-box controversies, and the thick description of Nature/Society dichotomy.

The dimension of Industrial Archaeology should be integrated to offer the exploration guide of previous works[6]; all production and reflection could be an interesting point of reference to analyze the intercontinental gap and to verify the constant problem of the intermittent duration of the Solar Energy Technologies in XIX and XX centuries.

The circulation of ideas and objects and their transboundary motion are crucial concepts to revise the narratives about the evolution of technology. *Patrimonialisation* is a phenomenon that stimulates a complex comprehension of the social relevance of the memories about objects and places[7]. We assume that Ecological Economy contributes to the deconstruction of the spectrum of the narrow interpretation from the classic economy[8], in a similar way than the visual studies of Victor Stoichita among several others[9]; and the fundamental

6 NEAVERSON, P., & PALMER, M. (2012) *Industrial archaeology: principles and practice*, London, Routledge; HUDSON, K. (2014) *Industrial archaeology: an introduction*, London, Routledge (originally published in 1966); MINCHINTON, W. (1983) "World industrial archaeology: a survey", *World Archaeology*, 15(2), 125-136.

7 GEERTZ, Clifford (2003) *La interpretación de las culturas*, Barcelona, Gedisa. [translated from: GEERTZ, Clifford (1973) *The Interpretation of Cultures*, Nueva York, Basic Books, Inc.]; GIBERT, Jorge; GÓMEZ, Andrés; CANCINO, Ronald (2017) *Ciencia, tecnología y sociedad en América Latina: la mirada de las nuevas generaciones*, Santiago de Chile, RIL editores.

8 HIBBARD, K. A.; CRUTZEN, P.; LAMBIN, E. F.; LIVERMAN, D.; MANTUA, N. J.; MCNEILL, J. R.; MESSERLI, B.; STEFFEN, W. (2007) "The Great Acceleration". In: COSTANZA, R.; GRAUMLICH, L. J.; STEFFEN, W. (eds.) *Sustainability or Collapse? An Integrated History and Future of People on Earth*, Dahlem Workshop Report 96, Cambridge, MIT Press, 341-378; THOMAS, Julia (2017) "Historia económica en el Antropoceno: cuatro modelos", *Desacatos*, 54, 28-39.

9 STOICHITA, V. I. (2006) *Simulacros: el efecto Pigmalión: de Ovidio a Hitchcock*, Madrid, Siruela [translation from: *The Pygmalion Effect: From Ovid to Hitchcock. Towards a historical anthropology of Simulacra*, Chicago, University of Chicago Press]; BARTHES, Roland (2009) *La Cámara*

basis arises: energy and matter[10].

This argument is necessary because we are in front of a peculiar phenomenon, which cannot be explained easily or linearly[11]. In a sustainability perspective, the invention of tools to harvest the solar radiation seems an extremely smart decision. Nonetheless, the myths about Energy and Civilization that George Basalla analyzed in 1978 are still active, imposing a type of barrier other than rationale, the benefits, the profits, and efficiency[12]. Then, our search is orientated to explore cultural factors summarized as Social Values traduced as Technological Fix[13] and Energy Myths.

Lúcida, Barcelona, Editorial Paidós; ALVARADO, M.; MASON, P. (2001) "La desfiguración del otro: sobre la historia de una técnica de producción del retrato 'etnográfico'", *Aisthesis*, 34, 242-257; REINERT, Kathrin (2017) "Saber e imaginación: fotografías científicas de los legados Uhle y Lehmann-Nitsche". In: SANHUEZA (ed.) (2017a), 149-168.

10 BOUVIER, Yves; PEHLIVANIAN, Sophie (2013) "Introduction", *Annales historiques de l'électricité*, 1, 11, 8-10; BOUVIER, Yves; LABORIE, Léonard (dir.) (2016) *L'Europe en transitions. Énergie, mobilité, communication. XVIIIe-XXIe siècles*, Paris, Nouveau monde éditions; BERGER, P. L.; LUCKMANN, T. (1968) *La construcción social de la realidad*, Buenos Aires, Amorrortu; DE CERTEAU, Michel (2010) *La invención de lo cotidiano*, México, Universidad Iberoamericana; BLANCO, Gustavo (2016) "La Vida Social de la Energía: Trayectorias Territoriales de la Energía en tres regiones del Sur-Austral de Chile", Fondecyt Nº 1160857: Ciencias Sociales, Sociología, Cambio Social y Desarrollo. Concurso Nacional Regular 2016.

11 DE LANDA, M. (2011) *Mil años de historia no lineal*, Barcelona, Gedisa [Translation from DE LANDA, M. (1997) *A thousand years of nonlinear history*, New York, Swerve Editions]; VILLALOBOS, Sergio (1983) *Historia de la energía en Chile*, Santiago, Museo Histórico Nacional de Chile.

12 BASALLA, G. (1979) "Energy and civilization", *EPRI Journal*, 4, 6, 20-25; BASALLA, George (1982) "Some persistent energy myths", *Energy and transport: Historical perspectives on policy issues*, 15, 27-38; BASALLA, George (2011[2]) *La evolución de la tecnología*, Barcelona, Editorial Crítica; GOUDSBLOM, J. (2012) "Energy and civilization", *International Review of Sociology*, *22*, 3, 405-411; HUGHES, Thomas (1993) *Networks of power: electrification in Western society, 1880-1930*, Baltimore, John Hopkins University Press; SMIL, V. (2017) *Energy and Civilization: A History*, Cambridge, MIT Press; RAY, D. L. (1983) "Energy and civilization", *Nuclear and Chemical Waste Management*, *4*, 1, 3-7; ISSAWI, C. (1991) "Technology, energy, and civilization: Some historical observations", *International Journal of Middle East Studies*, 23, 3, 281-289; STERN, D. I. (2004) "Economic growth and energy", *Encyclopedia of Energy*, *2*, 147, 35-51; STERN, D. I. (2011) "The role of energy in economic growth", *Annals of the New York Academy of Sciences*, *1219*, 1, 26-51. More recently Dr. Geoffrey Jones have been studying empirical information, see: JONES, G. (2017) *Profits and sustainability: A history of green entrepreneurship*, Cambridge, Oxford University Press; JONES, G. (2018) *Varieties of Green Business: Industries, Nations and Time*, Cambridge, Edward Elgar Publishing; JONES, G.; LUBINSKI, C. (2014) "Making 'Green Giants': Environment sustainability in the German chemical industry, 1950s–1980s", *Business History*, 56(4), 623-649.

13 JOHNSTON, S. F. (2018a) "Alvin Weinberg and the promotion of the Technological Fix", *Technology & Culture*, 59 (3), 620-651; JOHNSTON, S. F. (2018b) "The Technological Fix as Social Cure-All: Origins and Implications", *IEEE Technology and Society Magazine*, 37(1), 47-54; JOHNSTON, S. F. (2017) "Technological parables and iconic illustrations: American techno-

This perspective delineates a research frontier in which analyzing the combination of patrimonialisation, and the myths of energy. There are a number of cases for doing this, although it would be better to focus on stories from Europe and Atacama Desert, in South America, than to draw a review of the worldwide state of art[14].

The central question that raised from a heuristic trajectory would be: How did the technological fix and the social values interact producing discard, intermittency, and continuities in different solar energy technologies?

Our proposal is to re-unify the events or to have a geographically more comprehensive perspective, and to re-read borders and frontiers[15] because the studies about solar energy landscapes and their obliterated heritage are an excellent opportunity to connect History of Technology, Industrial Archaeology and, beyond them, Humanities, Social Science, and Art.

The strategic way to access to these kind of memories has been the history of engineering throughout archives of patents, designs, business records, letters, memorabilia, photographs, oral history, and, mostly, papers from professional and academic journals[16]. All these sources are stored in archives at Latin America, Europe, Australia, and United States of America[17].

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cracy and the rhetoric of the technological fix", *History & Technology*, 33(2), 196-219.

14 MEDINA, Eden, DA COSTA MARQUES, Ivan, HOLMES, Cristina (2014) *Beyond Imported Magic: Essays on Science, Technology, and Society in Latin America*, Cambridge, MIT Press.

15 GONZÁLEZ, S.; ARTAZA, P.; CALDERÓN, R. (2016) "El fin del ciclo de expansión del salitre en Chile: la inflexión de 1919 como crisis estructural", *Revista de Historia Industrial*, *25*, 65, 83-110; GONZÁLEZ MIRANDA, S.; OVANDO SANTANA, C. (2017) "Sama y Camarones: Las fronteras que no fueron entre Perú y Chile", *Revista de geografía Norte Grande*, 66, 61-82; LLORCA-JAÑA, M.; BARRÍA, D. (eds.) (2017) *Empresas y empresarios en la historia de Chile: 1810-1930*, Santiago de Chile, Editorial Universitaria.

16 Some archives: ETSEIB, UPC - Barcelona Tech; National Archives: Chile and USA; Universidad Santa María [Valparaíso, Chile]; Fundazione Luigi Micheletti, Brescia, Italy; Imperial College, London; Metropolitan Archives; Massachusetts Institute of Technology's Special Collections, among others. Other archives no yet explored for the author: Arizona State University, University of Florida, Melbourne (Australia), and Freiburg (Germany).

17 KLEICHE DRAY, M. (2017) *Les ancrages nationaux de la science mondiale, XVIIIe-XXIe siècles*, Paris, Éditions des archives contemporaines, en coédition avec IRD Éditions; VESSURI, Hebe; KREIMER, Pablo (2017) "Les sciences en Amérique latine. Tensions du passé et défis du présent". In: KLEICHE DRAY (2017), 99-134; GREVE, Ernesto (1938) *Historia de la Ingeniería en Chile*, Santiago de Chile, Imprenta Universitaria; HEADRICK, D. (1989) *Los instrumentos del Imperio. Tecnología e imperialismo europeo en el siglo XIX*, Madrid, Alianza Editorial; IBÁÑEZ, Adolfo (1983) "Los ingenieros, el estado y la política en Chile: del Ministerio de Fomento a la Corporación de Fomento: 1927-1939", *Historia*, 188, 45-102; IBÁÑEZ, Adolfo (2005) "Los ingenieros norteamericanos en la década de 1920 y su intento de construir un mundo feliz", *Boletín de la Academia Chilena de la Historia*, 71, 114, 87-107; MISA, T. J. (1988) "How machi-

The objective of this research note is to share this proposal trying to reassemble stories of solar energy technologies to recover a symbolic heritage. At the same time, we propose a new landscape of the re-unified loose memories providing a longitudinal perspective on the technological history of solar energy from the nineteenth century to our days[18]. Our proposal is developed in several steps: Section 2. Stories of Solar Energy Technologies; 3. Recovering (symbolic) heritage and (re)inventing landscapes; 4. Re-union of loose memories, and 5. Conclusions.

2.- Stories for a History of Solar energy technologies.

From the XIX century we observe a large number of inventions, some of them produced, apparently, in a fragmented process or, most precisely, in several independent trajectories.

Following this empirical information from sources, we focus on the inventions by Charles Wilson (1832-1901), who designed the first solar energy industry in the world in 1872; and by Manuel António Gomes (nickname: *Father Himalaya*) (1868-1933), and by Isidoro Cabanyes (1843-1915) as parallel colleagues at the Iberian Peninsula with other contemporary inventors in Europe, USA and South America[19].

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nes make history, and how historians (and others) help them to do so", *Science, Technology, & Human Values*, *13*, 3/4, 308-331; PARADA, Jaime (2011) "La Profesión de Ingeniero y los Anales del Instituto de Ingenieros de Chile. 1840-1927". In: SAGREDO, Rafael (ed.) *Anales del Instituto de Ingenieros de Chile. Ingeniería y sociedad 1889-1929*, Santiago de Chile, Centro de Investigaciones Diego Barros Arana de la Dirección de Bibliotecas, Archivos y Museos, ix-lxxvii; SANHUEZA, Carlos (2017b) *100 años. Escuela de Ingeniería y Ciencias 1917-2017*, Santiago, Universidad de Chile; VERGARA, Mario (2017) *80 años formando ingenieros mecánicos. Un camino de búsqueda, Realización personal y profesional. 1937-2017 Chile*, Valparaíso, Universidad Técnica Federico Santa María.

18 MARX, Leo (1994) "The idea of 'Technology' and Postmodern Pessimism". In SMITH; MARX (1994), 11-28; MARCUS, G. (2001) "Etnografía en/del sistema mundo. El surgimiento de la etnografía multilocal", *Alteridades*, *11*, 22, 111-127; LATOUR, B. (1987) *Science in action: How to follow scientists and engineers through society*, Cambridge, Harvard University Press; KOSELLECK, R. (2004) *Futures past: on the semantics of historical time*, New York, Columbia University Press [Spanish version: KOSELLECK, Reinhart (1993) *Futuro pasado. Para una semántica de los tiempos históricos*, Buenos Aires, Editorial Paidós]; KREIMER, P. (2010) *Ciencia y Periferia. Nacimiento, muerte y resurrección de la biología molecular en la Argentina. Aspectos sociales, políticos y cognitivos*, Buenos Aires, EUDEBA; KUBLER, George (1988) *La configuración del tiempo: Observaciones sobre la historia de las cosas*, Madrid, Nerea.

19 From the XVIIIth century, the Western list of names also includes: Horace Benedict de

In a second period, in middle XX century, the increasing interest in the exploration of solar energy drove the constitution of a worldwide network gathering academic researchers, inventors, enthusiast, and even some diplomats. This social environment allowed the emergence of other continental organizations: Coopération Mediterranéenne pour l'Énergie Solaire (COMPLES) (1962), Conferencia Latinoamericana para el Estudio de las Regiones Áridas (1963), Solar Radiation and Radiation Balance Data (*Данные солнечного излучения и радиационного баланса*), Leningrad – *Ленинград*, [World Meteorological Organization & Voeikov Main Geophysical Observatory] (1964).

Even though we have the information about the existence of these organizations, we do not have an analysis of data about the eventual connections between them. Nevertheless, some research by Dr. Yves Bouvier and by Dr. Sophie Pehlivanian would open some doors[20]. These historians studied some aspects from COMPLES' archives. Their research is a very important contribution to complete the complex and obliterated mosaic of networks and relationships able to produce a knowledge, nevertheless, mostly discarded.

On the other hand, the Chilean cases from 1872 have some kind of connection with European and USA researchers and institutions. Nonetheless, a nationalist methodology tend to produce a fragmentary and limited vision of the facts. Our cases allow to re-assembly and link facts and structures for observing change and continuity exploring the forces of history[21].

A short review about cases from Portugal, Spain, France, Italy, Massachusetts, New York, Tunisia, and Chile is the constellation of stories to assemble for building an integrative narrative, recovering a symbolic heritage and producing a new industrial landscape.

3.- Recovering (symbolic) heritage and (re)inventing landscapes.

Heritage and Patrimonialisation are interesting phenomena, and, at the

Saussure (1740-1799), Claude Pouillet (1791-1868), John Ericsson (1803-1889), Auguste Mouchot (1825-1912), Abel Pifre (1852-1928); Alessandro Bataglia (1842-?). For others Chilean cases see: ESCOBAR, B.; ARELLANO, N. (2019) "Green Innovation from the Global South: Renewable Energy Patents in Chile, 1877–1910", *Business History Review*, 93, 379-395.

20 PEHLIVANIAN, S. (2014) *Histoire de l'énergie solaire en France: science, technologies et patrimoine d'une filière d'avenir,* Doctoral dissertation, Grenoble (unpublished).

21 In the sense that Leo Marx and Merrit Roe Smith invited us to think about the technological determinism.

same time, they are controversial. The dualism Nature/Society studied by Philippe Descola, Gísli Pálsson, Tim Ingold, among several others, is a crucial conceptualization to try to understand the institutionalization of memory and conservation.

Solar Energy Technologies would be an unofficial collection of preserved wholes of pictures, snapshots, objects, tool, records, papers, maps, design, letters, and places. All this disintegrated mass of memories from stories of engineering constitute a symbol of the, nowadays, counterintuitive former future that is susceptible to be absorbed by the futuristic (possible future) narrative.

The complexity of Solar Energy Technologies heritage comes from many conditions for being a mere continuity for the successes, and for individual persistence story. It seems easy to build a story from the endurance of a visionary elite group of engineers fixing future problems of sustainability[22]. Nevertheless, our proposal implies the recognition of less glamorous behaviors, and focuses the attention on inconsistency, lazy, misconduct, or, in a kind of summary, an anti-hero profile.

Our aim is to contribute to a more equalizer harmony of the narratives of the silence and the shapes of the oblivion[23]. We are at the beginning of the proposal for a new order in relation to the entanglement condition of the viable alternatives to the technologies perpetuated by the selection process, following what George Basalla says.

This mosaic will be disposed in geographical terms, given that solar radiation is not distributed on the earth surface in equal ways. This means that not all landscapes have the same aesthetics. In addition, we cannot lose the perspective that the industrial application of harvested and domesticated solar radiation is an anthropisation and modelisation of the landscape.

The invention and re-invention of the landscape, therefore, will be an emblematic point to start and end analyzing. Beyond that, the Solar Energy Technologies historical sites are empty spaces. Those localities, most of them at deserts, had facilities that were vanished, and their material reconstruc-

22 JOHNSTON (2018a, 2018b, 2019).

23 BURKE, P. (1996) *Hablar y callar: funciones sociales del lenguaje a través de la historia*, Barcelona, Gedisa; BURKE, P. (2001) *New perspectives on historical writing*, Penn, Penn State Press; BURKE, Peter (ed.) (2003) *Formas de hacer historia*, Madrid, Alianza Ensayo; PRINS, Gwyn (2003) "Historia Oral". En: BURKE (2003), 144-176; THOMPSON, P. (2017) *The voice of the past: Oral history*, Oxford, Oxford University Press.

tion do not seem a reasonable action[24]. This fact demands again a serious reflection about heritage and patrimonialisation[25]. One alternative to open the discussion would be to re-unify loose memories and the governance that operates about[26].

Fig. 1. Ancient Solar radiation measurement instruments. Universidad Santa María, Valparaíso, Chile. Source: Collection by the author.

4.- Re-union of lost memories.

This complexity could be organized in an apparently linear timeline from XIX century to nowadays. Keeping this idea in mind our project offers nine cases from the Western world from 1872, linking the Atacama Desert with the

24 WENZEL, P., LACHENAL, G., MANTON, J., & TOUSIGNANT, N. (2016) *Traces of the future: an archaeology of medical science in Africa*, Chicago, University of Chicago Press.

25 DELANTY, G., & MOTA, A. (2017) "Governing the Anthropocene: Agency, governance, knowledge", *European Journal of Social Theory*, *20*, 1, 9-38; DESCOLA, Phillip y PALLSON, Gísli (2001) *Naturaleza y sociedad. Perspectivas antropológicas*, México DF, Siglo XXI; PODGORNY, Irina (2017) "Hacia una historia burocrática de las ciencias", 19-54, en: Sanhueza, Carlos (ed.) (2017a) *La movilidad del conocimiento científico en América Latina* (…) op. cit.

26 IBARRA, C., O´RYAN, R. AND SILVA, B. (2018) "Applying knowledge governance to understand the role of science in environmental regulation: the case of arsenic in Chile", *Environmental Science & Policy*, 86, 115–124.

circulation of ideas, technologies, environments, and people[27].

At the concept of time for this research, we propose to read the cases like thresholds: every experience at their moment offered an opportunity for a new path, and the effect could be suspended, even, for the near future. As it will be read, some of these thresholds were connected in certain ways. This general scheme reduces the anxiety for the innovation and supposes the accumulative mood of knowledge because most of the problem is not the technical challenge but the symbolic cultural heritage.

Fig. 2. Patricio Espejo, researcher. Location: Las Salinas, Atacama Desert, where the first solar energy industry in the world (1872) was installed. Source: Documentary "Historias de Sol", an edition by Universidad Santa María, Valparaíso, Chile.

After all these considerations, the problem of sustainability is also a problem of the narratives and of the empty ideological conception of the technological determinism, where society seems submitted to the technocracy.

The conceptual and analytic tool to produce the agglomeration of the loose memories is provided by Peter Burke, in whom Social History explore the *Art of the conversation* and the matters related with the speak and the

27 ARELLANO, N. (2019) "Éxitos y descartes de las tecnologías de la energía solar en la industria de los nitratos (1872-2012). Exploraciones en los archivos de una historia fragmentada". En: VALENZUELA, Carolina (ed) *Tendencias y perspectivas de la cultura científica en Chile entre los siglos XIX y XXI*, Santiago de Chile, RIL Editores (in press); ARELLANO, N. (2019) "La investigación y desarrollo de la energía solar en Chile (1872-1958)". En SILVA, IBARRA; OSSES (eds.) *Historia de la energía solar en Chile*, in press; ARELLANO, N. (2019) "Propuestas y resultados: la paradoja del país de la mayor radiación solar en el mundo que descartó las tecnologías para aprovecharlo (1958-2011)". En: SILVA, IBARRA; OSSES (eds.) *Historia de la energía solar en Chile*, in press.

silence. This observation can be connected with the *Shapes of the forget* by Marc Augé[28], which go through the thresholds of the selected memories allowing to reconstruct the narratives from loose emblematic memories, according to the theoretical political history proposed by Steve Stern[29].

Fig. 3. Engineer Pedro Sarmiento with instruments for solar measurements. Source: Documentary "Historias de Sol", an edition by Universidad Santa María, Valparaíso, Chile.

5.- Conclusions.

After almost 10 years of research on the history of technology with solar energy, from the XIX century to the XXI, we are able to state that there is an interesting case to study the connections between Technology and Heritage.

The sources indicate that is possible to re-shape the industrial landscape recovering discarded artifacts, objects, and technologies; nevertheless, this would be a big challenge. As well as it is a necessary step to reconsider the obliterated heritage. The material culture should be cataloged, and exhibited.

It is demonstrated that the recovering and preservation of memories would be the highest task. The geographical and chronological development of the facts and events demands a strong call for the attention of the acade-

28 AUGÉ, M. (1998) *Las formas del olvido*, Barcelona, Gedisa.

29 STERN, S. J. (2006) *Battling for hearts and minds: Memory Struggles in Pinochet's Chile, 1973–1988*, New York, Duke University Press.

mic community, as well as the contribution of people from politics, business, NGOs, state sector, and, beyond social structures, common people who are eyewitnesses.

This essay, focused on the lost industrial heritage, expresses that this is a history that must be studied, and it is worth being spread.